ERDC Letter Report

Environmental Laboratory

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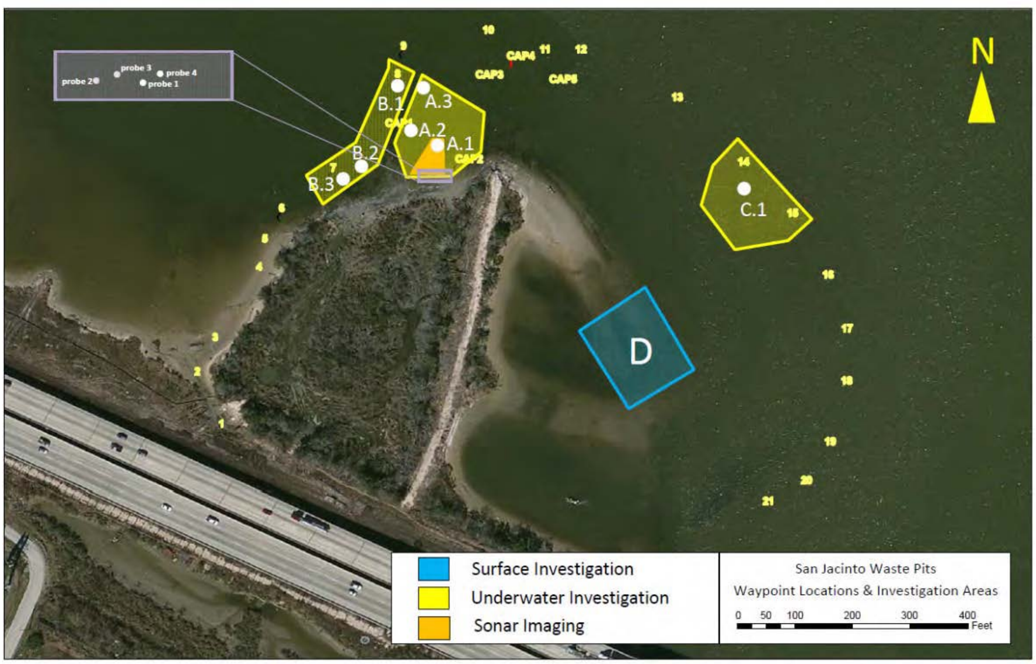
Evaluation of the San Jacinto Waste Pits Cap Defect

June 2016

Carlos E. Ruiz



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ERDC Letter Report

Evaluation of the San Jacinto Waste Pits Defect

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Letter Report

Prepared for U.S. EPA, Region 6
Dallas, TX 75202

Abstract

The U.S. Army Engineer Research and Development Center (ERDC) is providing technical support to the US Environmental Protection Agency (EPA), the goal of which is to prepare an independent assessment of an armor cap deficiency area on the northwest part of the San Jacinto River Waste Pits armor cap at the San Jacinto River Waste Pits Superfund Site, Texas. Specific tasks of this study are the following:

1) Conduct a review of the construction, inspection, and maintenance documents for the cap.
2) Prepare recommendations for additional underwater inspections and surveying of the entire site to insure there are no more deficient areas in the cap.
3) Conduct a review of the inspection protocols and prepare recommendations for improvement.
4) Consider alternatives for the cause of the deficient area and prepare a determination of the most likely cause.
5) Conduct a review of the available sampling results and prepare a determination of the extent of any release of material from the deficient area and the need for any additional sampling, if appropriate, to determine the nature and extent of any release.
6) Prepare an evaluation of the contents of the release with respect to all major contaminants at the site.
7) Prepare recommendations for any steps to prevent any future breaches to the cap.

This report presents the results of these seven tasks that were identified by EPA for the ERDC to perform in their assessment of armor cap deficiencies. The results are summarized in the Executive Summary section which precedes the reports individually of the seven tasks.

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Preface

This study was performed at the request of the U.S. Environmental Protection Agency (EPA) – Region 6 by the Environmental Laboratory (ERDC-EL) of the U.S. Army Engineer Research and Development Center (ERDC), Vicksburg, MS.

At the time of publication, the Deputy Director of ERDC-EL was Dr. Jack Davis and the Director of ERDC-EL was Dr. Elizabeth C. Fleming. Commander of ERDC was COL Bryan S. Green. The Director of ERDC was Dr. Jeffery P. Holland.

Unit Conversion Factors

Multiply	By	To Obtain
Feet	0.3048	meters
miles (U.S. nautical)	1,.852	kilometers
miles (U.S. statute)	1.609347	kilometers
Acres	4,046.873	Square meters
cubic yards	0.7645549	cubic meters
Knots	0.5144444	Meters per second

Executive Summary

Numerous tasks were performed to assess the armor cap deficiency area on the northwest part of the San Jacinto River Waste Pits armor cap. The technical evaluation included a) an evaluation of the armor cap inspection protocol and recommendations for its improvement, b) a recommendation for underwater inspection and surveys to identify and correct other potential cap deficiency areas, c) an assessment of the probable cause of the cap deficiency area and if it was a vessel strike, recommendations for what can be done to prevent further incidents, and d) an assessment of the potential releases from the exposed cap in the deficiency area and the need to further collect samples to determine the impact of the cap deficiency area on the surrounding sediments. Tasks 1, 2, and 3 addressed the site inspections, maintenance, repair, and ways to improve the cap integrity and thus ensure its performance. Task 4 evaluates the probable cause of the armor cap deficiency area and Task 7 recommends measures to prevent another cap breach. Tasks 5 and 6 evaluate the releases from the exposed cap in the deficiency area and the need to further collect samples to assess the short-term and long-term impact of the cap deficiency area on the surrounding sediments. Specific objectives of this study are the improvement of the armor cap inspections and maintenance to ensure the integrity of the cap, the identification of what caused the cap deficiency area, and the assessment of what is the impact of the exposed sediment in the armor cap area on the surrounding sediments of the San Jacinto River.

Cap Integrity and Performance

To maintain and ensure the desired performance of the cap, cap integrity must be verified and maintained. Cap integrity requires a determination of cap stability and permanence; in particular, a determination as to whether the cap was constructed as designed and whether displacement of cap material has occurred. As a minimum the semiannual bathymetric survey with increased manual probing should be maintained. This will build confidence that the survey's results can be used to create a better trigger in the future, resulting in less deficient areas. The trigger to perform manual probing needs to be reevaluated and a correlation developed that better relates the survey's results to discontinuities in the armor cap that are newly deficient areas. The only other alternative is to develop a new manual probing schedule with input from the underwater surveys. The inspection events need to line up with events that facilitate and enhance the ability to evaluate cap integrity such as extreme low tides and low barge traffic. A database of aerial photograph can serve as a baseline for future inspections.

Cap Deficiency

The assessment of the probable cause of the missing armor stone in the identified cap deficiency area included the evaluation of a possible barge or tug strike under normal flow conditions and under flood events and the thorough evaluation of the inspection and maintenance records performed to address the integrity of the existing repaired TCRA cap. After the evaluation of several flow events in the moderate slope of the Western Cell it is evident that a barge or tug strike would have resulted in greater damage, evidence of cap displacement, and more disruption to the cap than what was present. The deficiency area is most probably associated with the construction of the cap. Ground surveys show subsidence over time in the deficient area. The data leads us to belief that the defect area was caused by sinking of the cap over time due to either improper filter/support layer under the rock cap or unusual decomposition of organic matter under the area. The initial construction in the northwest area was spotty and a large area was deficient and required a second pass of capping to achieve sufficiency. This suggests that the construction did not have sufficient controls which probably led to the cause for the deficiencies. Additional deficient areas were found by manually probing the Eastern Cell, indicating potential construction deficiencies. None of the deficiencies found in the Eastern Cell compare in size to the area of the Western Cell.

Impacts of Release

The potential short-term and long-term impacts of the release of sediments from the exposed cap was evaluated using sediment data collected from the impacted area and nearby stations. Looking at the fingerprint of the sediment dioxins and furan data clearly shows that very little, if any; sediment from the cap deficiency area reached the two stations near the exposed sediment in the armor cap area. If one looks at the fingerprint of the data collected from the exposed area one sees that the fraction of TCDD to TCDF is not the similar to the fingerprint of the two sites away from the exposed cap where the fraction of OCDD is dominant. As presented in the Feasibility Report the fingerprint from the SJRWP exhibits a different pattern than the pattern from other sources of dioxins and furans in the vicinity of the site. The data from the sediment collection shows similar patterns; the exposed area has the fingerprint of the SJRWP and the data for the other two sites show similar fingerprint as that of other sources of dioxins and furans in the vicinity of the site. This further confirms that the exposed area did not release significant contaminants before it was repaired.

Project Background, Objectives and Tasks

Background

The San Jacinto River Waste Pits Superfund Site (Site) consists of several waste ponds, or impoundments, approximately 14 acres in size, built in the mid-1960s for the disposal of paper mill wastes as well as the surrounding areas containing sediments and soils potentially contaminated by the waste materials that had been disposed in these impoundments. The impoundments are located immediately north and south of the I-10 Bridge and on the western bank of the San Jacinto River in Harris County, Texas (see Figure 1).

Large scale groundwater extraction has resulted in regional subsidence of land in proximity to the Site that has caused the exposure of the contents of the northern impoundments to surface waters. A time-critical removal action was completed in 2011 to stabilize the pulp waste material in the northern impoundments and the sediments within the impoundments to prevent further release of dioxins, furans, and other chemicals of concern into the environment. The removal consisted of placement of a temporary armor rock cap over a geotextile bedding layer and an impermeable geomembrane in some areas. The total area of the temporary armor cap is 15.7 acres. The cap was designed to withstand a storm or flood event with a return period of 100 years.

The southern impoundments are located south of I-10 and west of Market Street, where various marine and shipping companies have operations (see Figure 1a). The area around the former southern impoundments is an upland area that is not currently in contact with surface water.

Goal and Objectives

The goal of this study is to provide technical support to U.S. Environmental Protection Agency (EPA) by conducting an independent assessment of an armor cap deficiency area on the northwest part of the San Jacinto River Waste Pits armor cap at the San Jacinto River Waste Pits Superfund Site, Texas. The assessment includes a review of existing information, identification of the possible cause for the deficiency, an evaluation of the potential releases from the deficiency, recommendations for additional data collection and inspections, and recommendations for improvements at the site or in the inspection and maintenance protocols.

Study Tasks

The following specific tasks were identified by EPA to accomplish the stated goal and objectives.

Task 1: Conduct a review of the construction, inspection, and maintenance documents for the cap.

Task 2: Prepare recommendations for additional underwater inspections and surveying of the entire site to insure there are no more deficient areas in the cap.

Task 3: Conduct a review of the inspection protocols and prepare recommendations for improvement.

Task 4: Consider alternatives for the cause of the deficient area and prepare a determination of the most likely cause.

Task 5: Conduct a review of the available sampling results and prepare a determination of the extent of any release of material from the deficient area and the need for any additional sampling, if appropriate, to determine the nature and extent of any release.

Task6: Prepare an evaluation of the contents of the release with respect to all major contaminants at the site.

Task 7: Prepare recommendations for any steps to prevent any future breaches to the cap.

Task 1

Statement

Conduct a review of the construction, inspection, and maintenance documents for the cap.

Findings

This task was performed by first reading all identified resources (*e.g.*, reports, letter reports, field activity reports, and the Operations, Monitoring, and Maintenance Plan (OMMP): Appendix N of the RACR – Anchor QEA 2012) provided by the Remedial Project Manager, Mr. Gary Miller. This information assisted in performing the requested assessment of the San Jacinto River Waste Pits (SJRWP) armor cap deficiency.

Construction of the existing TCRA cap was divided into three sections, each of which has different cap components (Figure 2). The Western Cell is generally above the water line; the Eastern Cell is mostly covered with less than 5 ft (1.5 m) of water; and the Northwestern Area is mostly in greater than 10 ft (3.0 m) of water. The Western Cell cap is composed of a geotextile filter, a geomembrane, geotextile cushion and armor stone. The Eastern Cell has a geotextile filter and armor stone. The Northwestern Area has predominantly granular filter blended with armor stone. These three sections were further subdivided into subsections with varying armor stone.

The inspections reported were conducted in accordance with the schedule established in the OMMP. The OMMP specifies the timing, pertinent items, tolerances, and procedures for inspection, maintenance, and repair of the armor cap, protective cover, fencing, and signage installed for the TCRA Site (Figure 2).

The EPA R6 Dive Team Operations Report dated 9-10 December 2015 documents the discovery of the deficiency in the Western Cell of the SJRWP armor cap. The study/inspection designed to safely assess ongoing SJRWP armor cap integrity and performance as measured by the continued physical integrity of the cap and lack of migration of dioxin from the waste pit beneath the Cap and into the San Jacinto River.

Figure 1a shows the areas of investigation and the area of the deficiency. The maintenance and repairs documented in the letter reports and field activity reports summarized the events and actions that followed the discovery of a deficiency in the western section of the SJRWP cap.

Maintenance and Repair Reports of the Deficiency of the SJRWP Armor Cap

Field Activity Report from EA Engineering dated 5 January 2016 describes the activities performed by the contractor EA Engineering, Science, and Technology, Inc., PBC (EA) performed oversight of field activities performed by the Potentially Responsible Party's (PRP) consultant, Anchor QEA (Anchor).

Activities included collected sediment samples from the following locations:

- Three samples from the suspected damaged cap area in the northwestern area of the cap
- Two samples from the northwest toe of the cap's sloped area
- Two samples approximately 50 feet from the northwest toe of the cap.

Other activities included the probing and repair of the deficiency by placing a non-woven geotextile in the location of the deficiency (Figures 3, 4, and 5) and placing armor stone over the textile to achieve the required depth of armor.

After the discovery of the SJRWP armor cap deficiency and the subsequent repair, the PRPs proposed further probing of the Eastern Cell as part of the OMMP for the site. The document proposes modifications of the OMMP by increasing the probing in the Eastern Cell and installing a camera monitoring system to record unauthorized visits/contact with the SJRWP armor cap and the site. Figure 6 shows the new probing and Table 1 the areas that were found to be deficient in armor thickness or exposed geotextile. The results of the probing and visual inspection identified several discrete areas (e.g. 1' x 1') where geotextile was exposed and subsequently repaired as summarized in Table 1. Figure 7 shows one of the cameras of the new security system installed.

Table 1
Armored Cap Maintenance Locations
March 2016

Maintenance Location	Comment	X (UTM NAD83 - 15N)	Y (UTM NAD83 - 15N)	Maintenance Plan
0	Exposed Geotextile with rock beneath. Indicative of Lap Joint.	300665.5156	3297847.47	Add rock
1	Exposed Geotextile is 2x2 feet. Some rock aggregate present. Thin cap rock region is 2x6 feet.	300672.5976	3297832.841	Add rock
2	Exposed geotextile 2x2 feet in area. Some rock aggregate present.	300672.013	3297833.713	Add rock
3	Exposed Geotextile 2x3 feet in area. Some rock aggregate present.	300680.1521	3297833.27	Add rock
4	Exposed Geotextile is 1x3 feet in area. Some rock aggregate present.	300675.29	3297763.589	Add rock
5	Exposed Geotextile is 1x1 feet in area. Some rock aggregate present.	300674.1382	3297763.769	Add rock
6	Exposed Geotextile is 1x1 feet in area. Some rock aggregate present.	300670.6068	3297767.763	Add rock
7	Exposed Geotextile is 1x1 feet in area. Some rock aggregate present.	300672.5902	3297771.977	Add rock
8	Exposed Geotextile is 2x1 feet in area. Some rock aggregate present.	300668.9628	3297815.019	Add rock
9	Exposed Geotextile is 1x1 feet in area. Some rock aggregate present.	300664.2992	3297818.844	Add rock
10	Exposed Geotextile is 2x2 feet in area. Some rock aggregate present.	300662.8045	3297821.023	Add rock
11	Exposed Geotextile, cause unknown. Some rock aggregate present. Possible joint.	300665.6821	3297858.861	Add rock and geotextile
12	Centroid for area of exposed geotextile and thin cap rock. Some rock aggregate present. 20 square feet of area total.	300676.9607	3297852.277	Add rock

Task 2

Statement

Prepare recommendations for additional underwater inspections and surveying of the entire site to insure there are no more deficient areas in the cap.

Methodology

This task was performed in two steps. The first step evaluated the OMMP for the SJRWQ site, the past inspections, the current inspections and the proposed modifications to the OMMP. The second step extracted what has worked and combined it with the site constraints (low underwater visibility, steep slopes, river traffic, and unstable environment) to develop a more thorough inspection protocol that would enhance the confidence of the cap integrity.

Evaluation of the inspections

The OMMP for the SJRWP site recommends semiannual (after 2014) surveys of the armor cap with manual probing of armor cap thickness at areas identified by the topographic or bathymetry surveys as more than 6 inches lower in elevation than during the prior survey. The problem with the trigger is that the cap surface is fairly rough and uneven resulting in a scenario that under predicts defects due to the nature of the cap surface (large stones and uneven surface). It is even more uncertain in the deeper sections of the cap due to low visibility, potentially unstable surfaces, and hard to work environment and in areas of steeper slopes due to positioning uncertainties and errors.

The surveys and trigger mechanism in place to monitor/inspect the armor cap would be applicable to a granular cap, like a sand or gravel cap, because of the smooth and continuous layer at the top of the cap. Surveys of sand caps are more useful, since the layers behave more like a continuous layer; in the armor cap, there are significant discontinuities in the surficial layer that could mask small imperfections in the armor cap. Therefore, a trigger based on changes in the surficial layer is not conservative, not unless there has been significant ground truthing of the bathymetric data against actual deficiencies. The probing done by the EPA team, the proposed supplemental probing (Figure 6) and the results of those inspections increase the confidence of the integrity of the cap. The surveys, though useful, have not shown the reliability of the probing; the problem with the probing is the lack of coverage of the site. To build the confidence of the cap integrity, more than ninety-five percent of the cap that is probed should be without defects. The results from the Eastern Cell were 12 deficiencies in four hundred probes; that is around ninety seven percent (97%) without significant defect, suggesting that defects are outliers of limited size.

The underwater scans and bathymetric surveys in combination with probing should improve the confidence in the cap integrity. The OMMP should strive to develop a consistent protocol for the surveys; at normal to low flows, with minimum winds/waves, and low barge traffic. The consistent surveys and the increased knowledge of the cap from the previous manual probing should lead to more confidence in the trigger. To increase the confidence in the cap integrity ground truthing of the surveys with manual probing is recommended to develop a relationship that will lead to a better trigger and more confidence in the cap integrity.

So as a recommendation, semiannual bathymetric survey with manual probing should be maintained; this will build up the confidence that the survey's results can be used to create a better trigger for manual probing. The results from the four hundred probing are encouraging, but we need to realize that the actual area of the cap that has been probed is probably less than thirty percent of the actual area. And again, this is not a smooth cap layer, so any method that will integrate over large surface area will not be conservative. Manual probing, though slow and hard at the deeper areas of the armor cap, is probably the more conservative method to guarantee the armor cap integrity.

The only way to guarantee that we will not find any more deficient areas is by inspecting all the surface of the cap below the water level; one can inspect it all at once or over a period of time when the conditions are more suitable to achieve our goal.

Task 3

Statements

Conduct a review of the inspection protocols and prepare recommendations for improvement.

Findings

Background

Inspection protocols for both the land portion of the armor cap and the submerged portion rely on surveys with triggers based on change in elevation as compared to an earlier survey or the baseline survey. For the land based cap it states that portions of the armor cap that are located above the water surface, or at a water depth too shallow to access by boat, will be surveyed using conventional land-based topographic survey techniques. The survey contractor will prepare a survey transect plan that will be sufficient to adequately measure the armor cap, but not less than an equivalent 25-foot by 25-foot grid. Horizontal and vertical measurements will be collected at 5-foot intervals and major breaks along these grid lines.

For the portion of the cap under water a bathymetry survey will be performed by boat at 25-foot intervals and the elevations will be compared to previous surveys to determine change in elevation over the discrete area. Elevation changes of more than 6 inches between surveys will be cause for additional evaluation. The elevations obtained from the survey will be re-checked and the survey benchmarks will be verified. If the most recent survey elevation differs by more than 6 inches when compared to the prior survey for an area larger than 30 feet by 30 feet, manual armor cap probing will be initiated to measure the cap thickness.

As stated in the previous task, the survey and technique can give us great insight on sections of the cap, but are not able to find minor imperfections as the ones discovered in the March Supplemental Probing and by the EPA diver team in December. The site has improved its monitoring in case of unauthorized contact or intrusion into the armor cap area. The cameras, the surveys and the supplemental probing are all moving in the right direction, but the cap integrity and the confidence in the cap integrity will not be achieve unless more discrete inspections are performed.

In particular the Northwestern Area, where construction of the cap in the very different than the other two cells and does not provide the same level of confidence in its long-term stability and performance due to its steep slope. The area is largely capped with twelve inches of non-uniform recycled concrete blended with granular filter material. Since it does not have a geotextile or a geomembrane, it's even more difficult to ensure that even the manual probing will result in assurances that the proper armor cap exists without mixing with the sediment. In both the Eastern and Western Cells the probing was done till it encounters the geotextile or geomembrane; distance above that is the thickness of the armor layer. Therefore more care and a more consistent approach needs to be develop to estimate where the probing encounters the sediment and where the bottom of the cap is. In addition, this area is probably the hardest to evaluate because of the slope, water depth, and lack of visibility.

Recommendations

The improvements to the inspection protocols are mostly based in what has worked before, the dive team, manual probing, and building a better database to relate the surveys with manual probing and develop a more relevant trigger. The OMMP should be modified to take advantage of low tides and extreme low tides, in particular, to perform visual inspections and look for defects, deficiencies, or disturbances in the armor cap.

Recommendations include supplemental probing like the one performed in the Eastern Cell; the goal is to reduce the number of deficiencies. Probing should continue to the Western Cell with the same density as what was performed in the Eastern Cell (200-250), and the finally to the Northwestern Area. Here is where it gets trickier; this area requires the greatest density of manual probing since it is the steepest and does not have a geotextile or geomembrane. Manual probing in the order of 300-400 is not out of the question based on the potential for deficiencies in this area due to construction and post-construction conditions.

Collect bathymetry and or ground surveys of area in need of maintenance or repair to aid in determining the cause of those repairs, thus gaining an inside long-term performance of the cap.

Task 4

Statement

Consider alternatives for the cause of the deficient area and prepare a determination of the most likely cause.

Findings

The methodology used to determine the cause of the deficient area included the following steps:

1) Evaluate the documents from the EPA Dive team, the action team, and other reports describing the area and deficiency.

2) Evaluate whether a barge or tug strike was the potential cause.

Deficiency Report

The EPA diver report and the Action reports described in Task 1 defined the area of the cap in the Northwestern Area that had no armor stone cover. The team did not mention the movement or displacement of stone or a ridge formed by a potential strike to the cap. The action reports mentions that there were some aggregates near the site where they collected sediment samples, but they do not mention the displacement of rock or the formation of a berm next to the deficiency or down slope of the deficiency. The sampling of the deficiency area showed the presence of some rock, characteristic of the blended filter rock but not of the larger recycled concrete, but not of nearly sufficient thickness as specified in the design.

The sonar evidence is not supportive of a barge strike, the quote from the report states that"Imaging sonar was utilized in this area in an attempt to visualize the area of deficiency. This area was not identifiable via sonar, but other areas of interest were identified based on changes in color within the sonar image (Image 4 and Map)." The sonar shows neither a depression nor a mound of displaced material. The pictures if they were collected from the impacted site show the only evidence of a potential berm or rock displacement, though not significant to account for a potential strike. Discoloration shows intrusion of sediment into the cap or mixing of cap with the surficial sediment or deposition of new sediment.

Another fact that support the ‘no strike hypothesis’ is that the EPA diver team on the ground did not see/report displaced rock or some unusual deformation of the armor stone placement. All of the above indicates that the deficiency is probably a cap defect during construction. In addition the diver team penetrated the deficiency and there was no mention of a depression in the area of the deficiency. The cap would either be displaced into a ridge or/and pushed down into the sediment bed because the sludge has little strength. If the cap was pushed down, then a depression should exist. The repair team mentioned that rocks and material appear as if they were pushed deeper into the sediments as a typical strike would do, however, there was no mention of a depression and there is no significant sediment transport in the area to fill a depression from a barge or tug strike. The repair team mentioned that visual inspections of the area in January 2013 and 2014 show no deficiency area.

Another potential cause of the deficiency is that the material (rocks) placed on the area sinked/settled over time, either because of bearing capacity of the sediment or excess load of the rocks placed at the area.

Probing of the Eastern Cell, after the deficiency area was discovered, resulted in another twelve areas with some deficiencies, so now this is not a single site without rock cover. The twelve defects in the Eastern Cell were much smaller; around one to two square feet each. The dispersed, isolated, small areas of mild slope would suggest that these additional deficient areas could not have been caused by erosion, slope failure or barge strikes. In addition, the presence of the geotextile would also suggest that the defects were not caused by subsidence or bearing capacity issues, leaving construction defects as the only remaining probable explanation. However, it tends to explain how difficult is to build a greater than ninety-nine percent perfect cap with large rocks, the tolerance for imperfections in such a large area is extremely small.

Barge Accidents/Strikes

Incidents involving barges are relatively infrequent. Hayter et al. 2015 estimated the probability of a barge striking the cap at 1 in 400 for a significant strike (flood conditions) and 1 in 50 for a low severity impact strike in a year; that is once in 50 years. That strike probability is the greatest for the Northwestern Area and much lower for the Western and

Eastern Cells. A significant strike for the Western and Eastern Cells is less than half of the strike probability of the Northwestern Area.

Impacts of Barge Strikes

Background

The potential impacts of barge strikes vary greatly with the nature and location of the barge strike. River barges have flat bottoms and square sides that influence the damage it can inflict to the cap; it is also a function of the angle of the strike and the slope of the cap. Empty barges have a draft much lower draft than loaded barges (2 ft versus 10 ft).

Water depth under normal conditions varies across the site such that the cap may be a couple of feet above the water level in the Western Cell, may be more than 15 feet below the water surface in the Northwestern Area, and generally between 0 and 5 feet below the water surface in the Eastern Cell. Slopes are very steep on the cell berms and shorelines including the Northwestern Area adjacent to the Western Cell.

Two potential barge impact conditions can be addressed to understand the potential for a barge to strike the armor cap north of the Western Cell (location shown in Figures 3, 4, and 5) based on flow condition, bottom slope, and water depth. Water depths under normal flow conditions greatly restrict the conditions and locations where a strike may occur. Moderate slope occurs throughout much of the interior of the Eastern Cell and along the northern end of the site, including north of the Western Cell in the Northwestern Area where the cap deficiency was discovered.

Normal Flow Strike

Shallow water (< 5 feet). Only the northern and easternmost sections of the Eastern Cell and the area immediately north of the Western Cell would be particularly susceptible to being struck by the nearby barge operations due to the currents. Of these sections only the northern end of the center berm and the area directly north of the Western Cell would have highly contaminated sediments. The only strike potential is grounding or beaching of the barge. The grounded barge would shear the armor layer and push some of the armor material ahead of the barge up the slope during grounding and pull some armor down the slope during barge removal, exposing perhaps as much as a thousand square feet of the sediment for moderate slopes and as little as several hundred square feet for mild slopes.

This strike would be expected to be a little bigger than what was discovered by the EPA diver team and the footprint of the defect does not match the approach/strike of the vessel. In addition, there was no significant displacement of the armor stone found and therefore this type of barge strike is unlikely to be the cause of the deficiency.

Flood Strike

Under flood scenarios, the water depths would tend to be 3 to 10 feet greater than under normal flow conditions. This would essentially eliminate any shallow water conditions except for the berms and shoreline; however, the potential for erosion of impacted areas becomes much greater.

Shallow water (normally <5 feet). Only the northern and easternmost sections of the Eastern Cell and the area immediately north of the Western Cell would be particularly susceptible to being struck by the nearby barge operations due to the currents. Of these sections only the area directly north and northeast of the northern end of the center berm and the area directly north of the Western Cell would have highly contaminated sediments. The only strike potential is grounding or beaching of the barge. The grounded barge would shear the armor layer and push some of the armor material ahead of the barge up the slope during grounding and pull some armor down the slope during barge removal, exposing perhaps as much as a thousand square feet of the sediment for moderate slopes and as little as several hundred square feet for mild slopes. Under this strike conditions the loss of sediment would be very large because of the river flow, Hayter et al. 2015 estimate up to 50 cubic yards could be lost. This would represent less than 0.1 percent of the contaminated sediment, and it would be widely dispersed and diluted with the suspended solids of the flood waters. This strike would be much bigger than what was discovered by the EPA diver team; it would have caused significant displacement of the rip rap and significant release of sediment, none of what was found at the site. Again, this type of barge strike is unlikely to be the cause of the deficiency.

Summary

The probability that a barge caused the deficiency of the SJRWP armor cap in the Northwestern Area is very small; the size of the impact (7 ft by 22 ft) is too small for a flat barge strike. The probability that a tug caused deficiency as the result of an impact with armor cap in the Northwestern Area is also very small due to the size of the potentially impacted area (slightly over 200 sq ft), the angle of the impact, and the shape of the deficiency where the wider section is next to the land side and the smallest section to the deeper water. The strike of a tug would leave the inverse footprint; it would be like the wake that a tug makes. All of the above leads us into the conclusion that the probability that the deficiency was caused by a vessel strike is extremely small, much smaller than the probability of the deficiency being the result of a flaw in the cap construction.

Appendix A shows why it is very hard to imagine that a vessel strike was responsible for the deficiency area. The discussion in Appendix A was after communication with the repair team; on what was found as they sample the deficiency area, and there speculation on a probable barge strikes. The lack of visual trace and the potential angle of impact does not lead us into accepting the vessel strike hypothesis.

Appendix B shows that the area of the defect has been changing in elevation since at least 2013 and maybe even 2012. The discussion in Appendix B was after communication with the repair team and there wiliness to provide us with ground surveys for the deficient area for the last six years. The data leads us to belief that the defect area was caused by sinking of the cap over time due to either improper filter/support layer under the rock cap or unusual decomposition of organic matter under the area.

Task 5

Statement

Conduct a review of the available sampling results and prepare a determination of the extent of any release of material from the deficient area and the need for any additional sampling, if appropriate, to determine the nature and extent of any releases.

Findings

Figure 8 shows the probing transects and samples collected as part of the assessment of the cap deficiency in December 2015. Figures 9 and 10 show the level of contaminant in the three sediment samples collected from the cap deficiency. Figure 9 is from the exposed sediment, the sample was split with EPA and documented in the report 05_San Jacinto RIFS OS Data Validation for December 2015 Split Sampling, a letter report.

The levels of the three samples collected from within the cap deficiency zone vary significantly; two are around 40,000 ng/kg and one is nearly an order of magnitude less (8180 ng/kg).

The levels of the two samples (SJNE085 and SJNE 086) from the northwest toe of the cap's sloped area near the cap deficiency area are shown in Figure 9. The levels are 500 times lower than the two highest values at the impacted zone and 100 times lower than the lowest value from the impacted zone.

The third set of sediment samples collected were two samples (SJNE87 and SJNE88) approximately 50 feet from the northwest toe of the cap also shown in Figure 8 and the results are also included in Figure 10. The levels are three orders of magnitude lower than the two highest values at the impacted zone and 300 times lower than the lowest value from the impacted zone. The values are three times lower than those samples collected near the northwest toe.

Based on the reduction in magnitude from the sediment in the impacted zone versus the levels of the sediment collected by the northwestern toe, one can say that there were no significant releases from the exposed cap. If one compares the values by the toe and fifty feet from the toe to the data from the Feasibility Document shown in Figure 11, the sediment collected from the non-impacted sites is close to the values in the historical data; both showing an increase as you get closer to the armor cap. Based on simple comparison and trends, one can say that the exposed sediment caused little increase, if any, in contaminant concentration to the surrounding sediment, in particular to those areas where the sediment was collected.

It would be desirable also to estimate the sediment concentration closer to the area that was repaired, in addition to the two other sites (the northwestern toe, and 50 ft from the toe) that were collected to determine the potential effect of the deficiency. A reduction in contaminant concentration at increasing distance from the deficiency would indicate a release from the exposed sediment; if the values in the proximity approach those of samples SJNE87 and SJNE88 then release from the exposed sediment would not have been significant.

In addition, the samples outside the armor cap area do not contain significant TCDD and TCDF levels as compared to those from the exposed sediment in the armor cap area (see Figure 9). This difference in the distribution of dioxins and furans between the two samples indicates that the contamination outside the armor cap area did not come from the exposed sediment in the armor cap area, providing another piece of evidence that the exposed sediment from the armor cap area did not contributed significant releases to the surrounding sediment.

Task 6

Statement

Prepare an evaluation of the contents of the release with respect to all major contaminants at the site.

Findings

The same analysis that was done for Task 5 applies here too. Since it was demonstrated that there was no significant increase in contamination at the two sites away from the exposed sediment in armor cap area as compared to historical data (Feasibility Report, Figure 11) then the release from the other contaminants should behave similarly. If one looks at the fingerprint of the contamination for the samples collected from the exposed sediment, one sees that ratio of TCDD to TCDF is not similar to the fingerprint of the two sites ((1)SJNE085 and SJNE 086, (2) SJNE87 and SJNE88) outside the armor cap where the fraction of OCDD is dominant. As presented in the Feasibility Report the fingerprint from the SJRWP exhibits a different pattern than the pattern from other sources of dioxins and furans in the vicinity of San Jacinto. Figure 12 shows the two models for dioxin and furan that describe the pit (EM2) and the outside of the pit (EM1).

Comparison of Figure 12 with Figures 9 and 10 shows that the fingerprint from the sediments collected in the deficient area is close to the EM2 model, while the data from the sites outside the exposed area follow the EM1 model. If sediment from the deficient area was released the impacted sites would exhibit a form of the EM2 model (fingerprint), one can say that there is a slight contribution by the short peak of TCDF, so most of the sediment from the toe and outside areas receive most of the loadings from other areas beside the SJRWP. In addition, the samples from the deficient area show evidence of deposition of sediment from outside the SJRWP due to presence of higher distribution of OCDD than in the EM2 model. The presence of deposition in the deficient area would indicate the long-term presence of the defect, the stability of sediment at the defect, and no significant release of contaminants from the deficient area.

Task 7

Statement

Prepare recommendations for any steps to prevent any future breaches to the cap.

Findings

If the concern is that the cap could be impacted from vessels or other external sources in the navigation channel, then one needs to address the needs for controls. The PRPs already installed a camera system to monitor the site and alert the PRPs that the cap has been impacted or that non-authorized personnel is in the site. As mentioned in Task 4, the probability of a vessel impacting the cap is very low (once every fifty years), and that the areas of concern are the Northwestern Area, north and northwestern part of the Western Cell, and the northeastern side of the Eastern Cell. In those areas more robust engineering controls to restrict vessel traffic over the long term could be considered such as the use of lighted buoys, caissons, or vessel exclusion barriers.

The FS suggested a five-foot high submerged rock berm outside the perimeter of the Permanent Cap to protect from potential vessel traffic. Shallow areas can be isolated using steel cable or chain with appropriate marine and land-based signage and markers to prevent vessel access.

Conclusions

Very small amount of sediment was released from the deficient area before it was repaired based of the comparison to the historical data, the SJRWP sediment chemical fingerprint (model EM@2), and the collected samples.

Samples from the deficient area show evidence of deposition of sediment from outside the SJRWP due to higher fraction of OCDD than in the EM2 model.

Presence of deposition in the deficient area indicates the long-term presence of the defect, the stability of sediment at the defect, and no significant release of contaminants from the deficient area.

Based on the angles of potential strike, the lack of a berm next to the defect area, the lack of impact to the rock berms near the defect area, and the ground surveys of the cap near the defect we can conclude that the probability of a tug or barge strike causing the defect is extremely small.

Based on all the above the most likely cause of the defect is subsidence due to inadequate construction controls.

Figures

Figure 1. San Jacinto River Waste Pits Superfund Site.

Figure 1a. San Jacinto River Waste Pits Superfund Site Location.

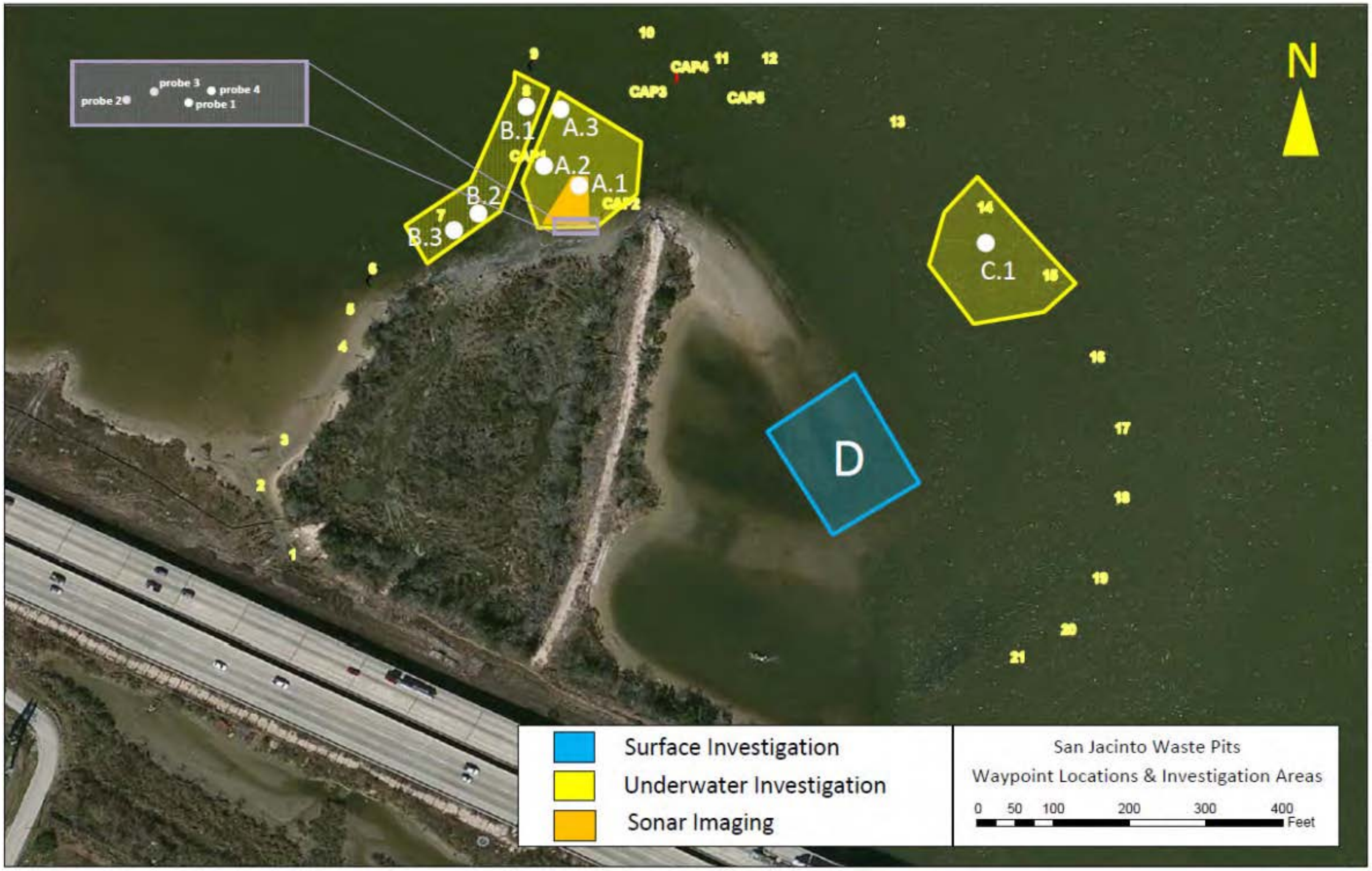

Figure 2. Cap components.

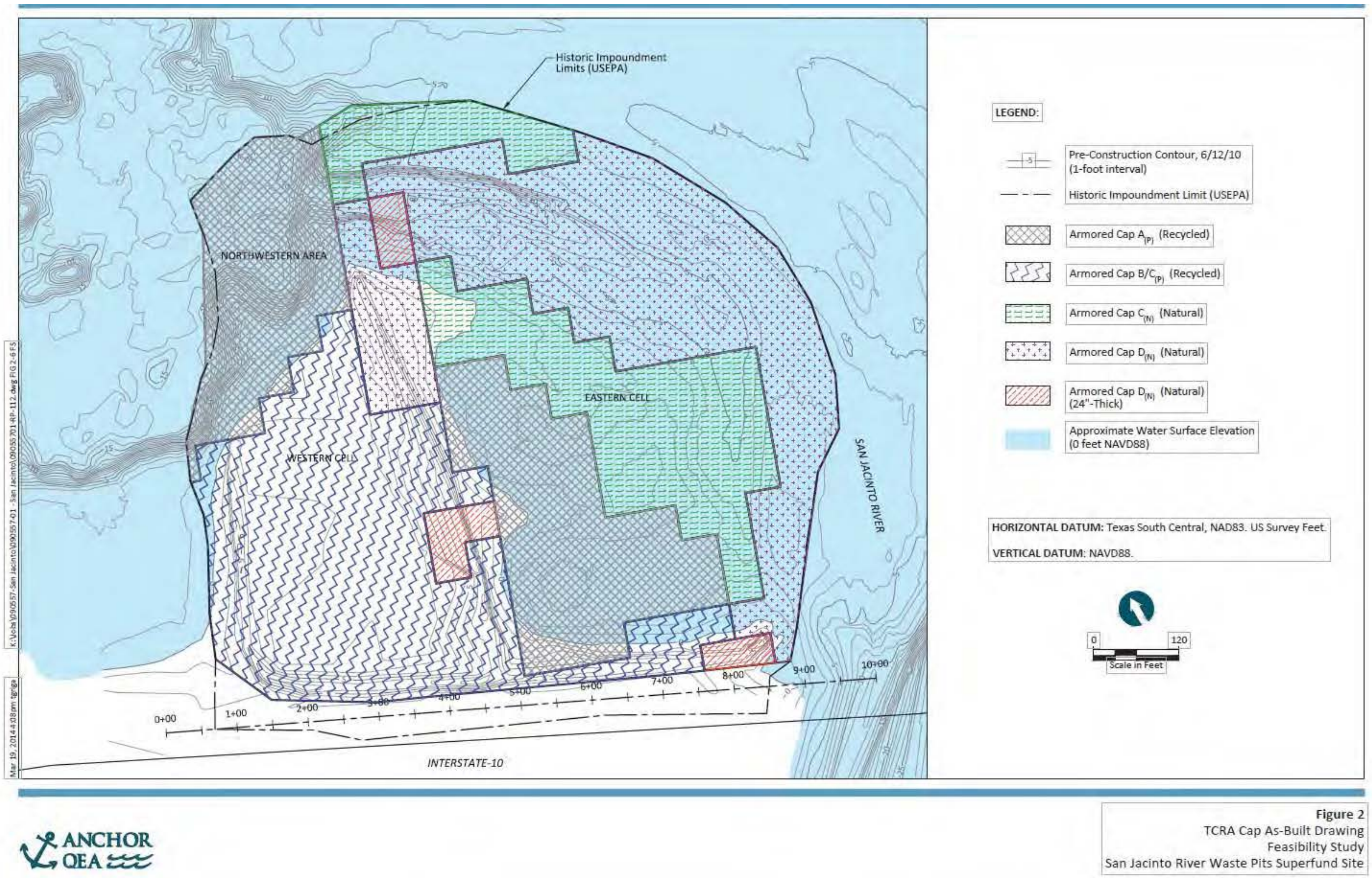

Figure 3. Summary of Probing Data Post TCRA Inspection.

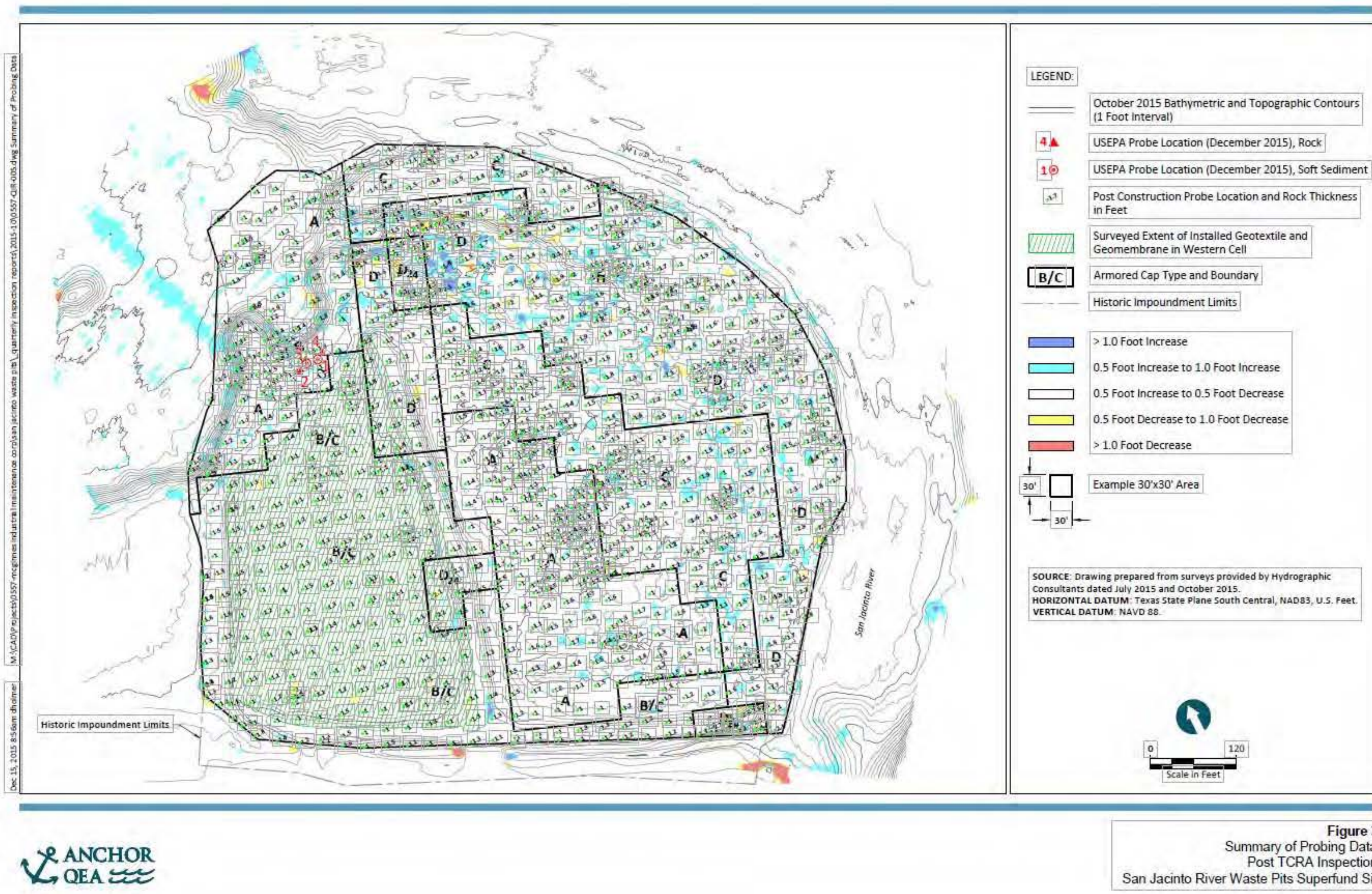

Figure 3
Summary of Probing Data
Post TCRA Inspection
San Jacinto River Waste Pits Superfund Site

Figure 4. Armor Rock Placement Plan and Cross Sections Post TCRA Inspection

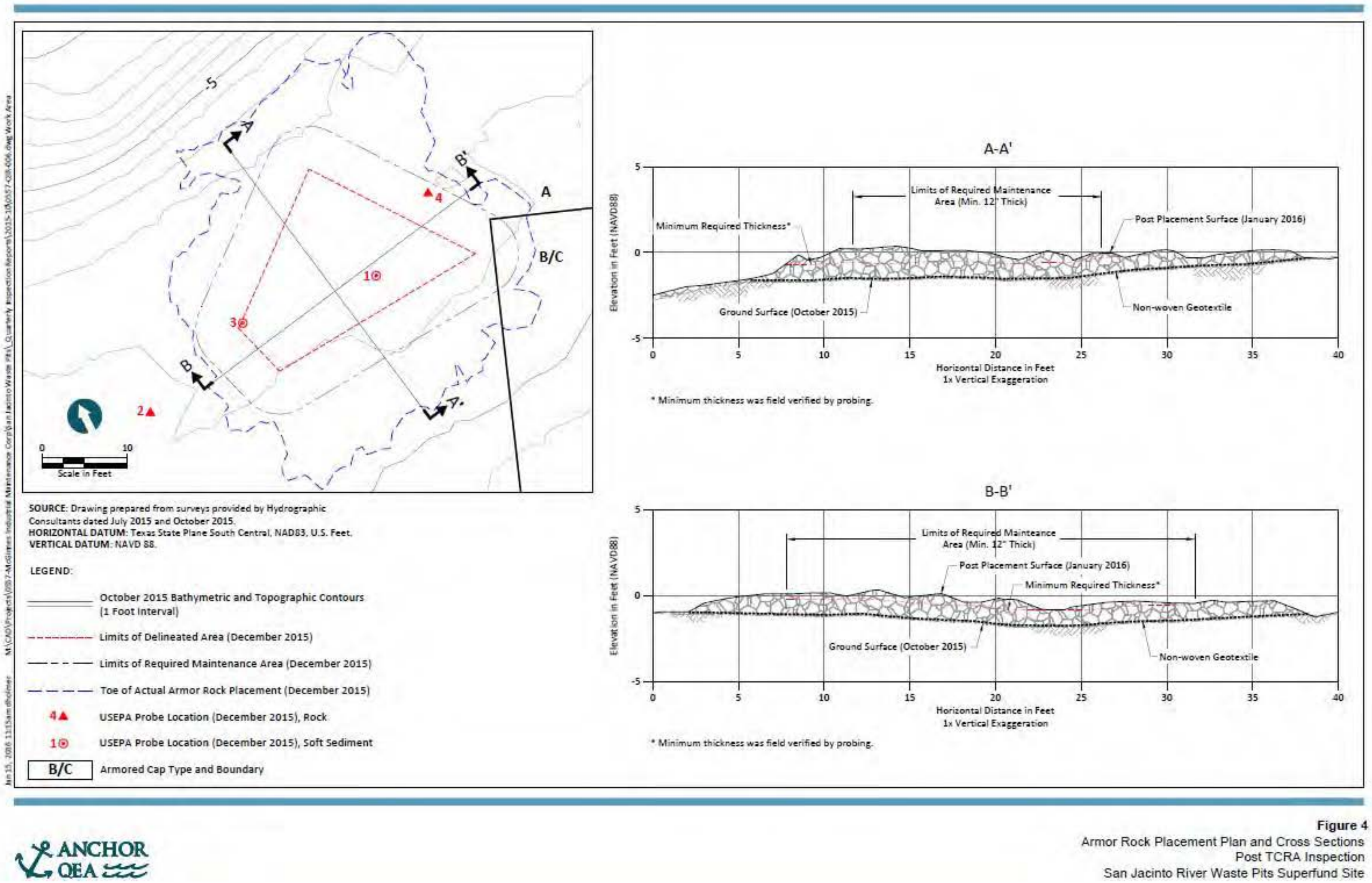

Figure 5. Rock Placement Area Post TCRA Inspection.

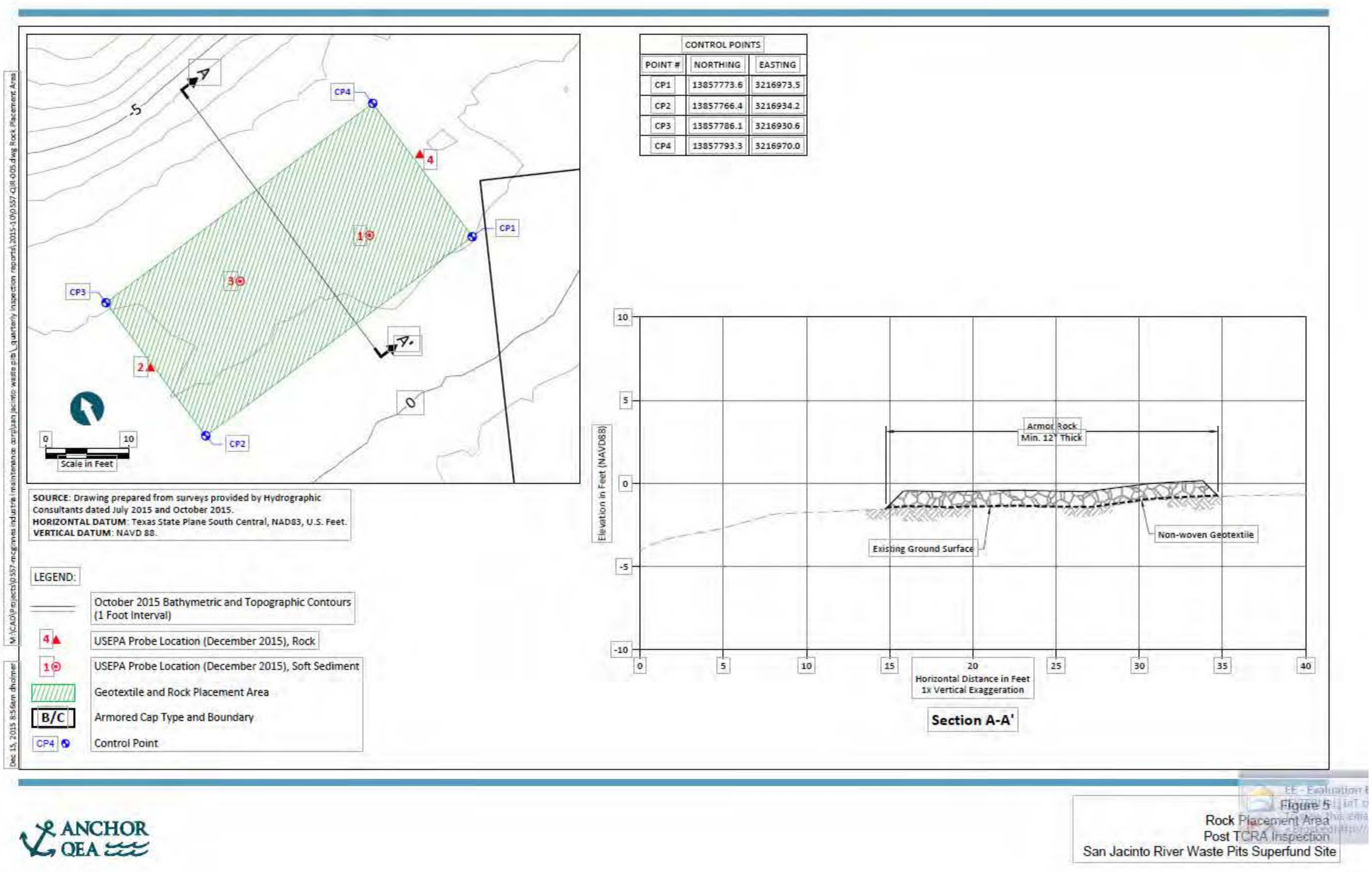

Figure 6. Proposed Supplemental Probing.

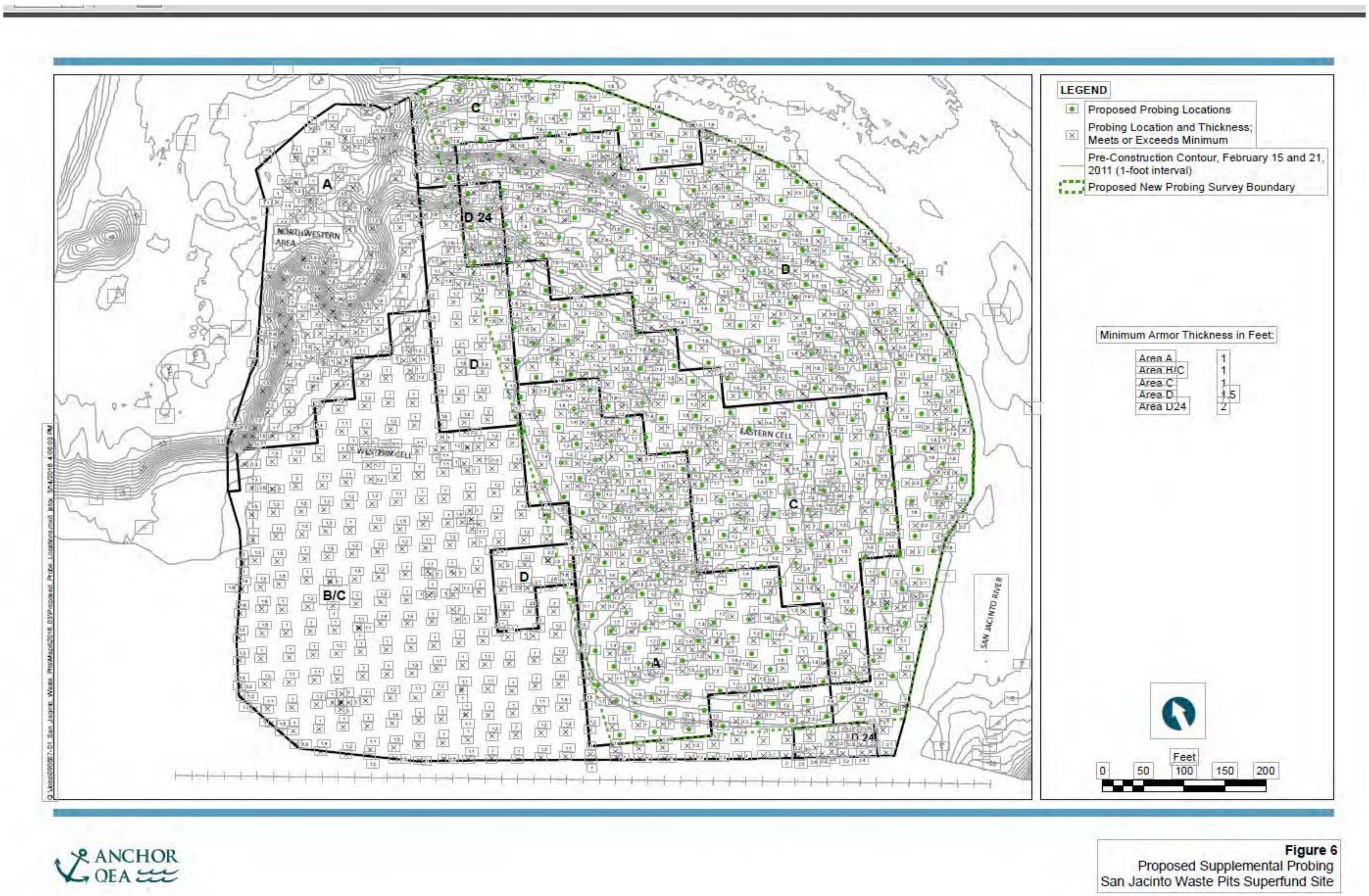

Figure 7. Security Camera Installed.

Figure 8. Probing and Sample Collection as part of Maintenance and Repair of the Deficiency Area of the SJRWP Armor Cap.

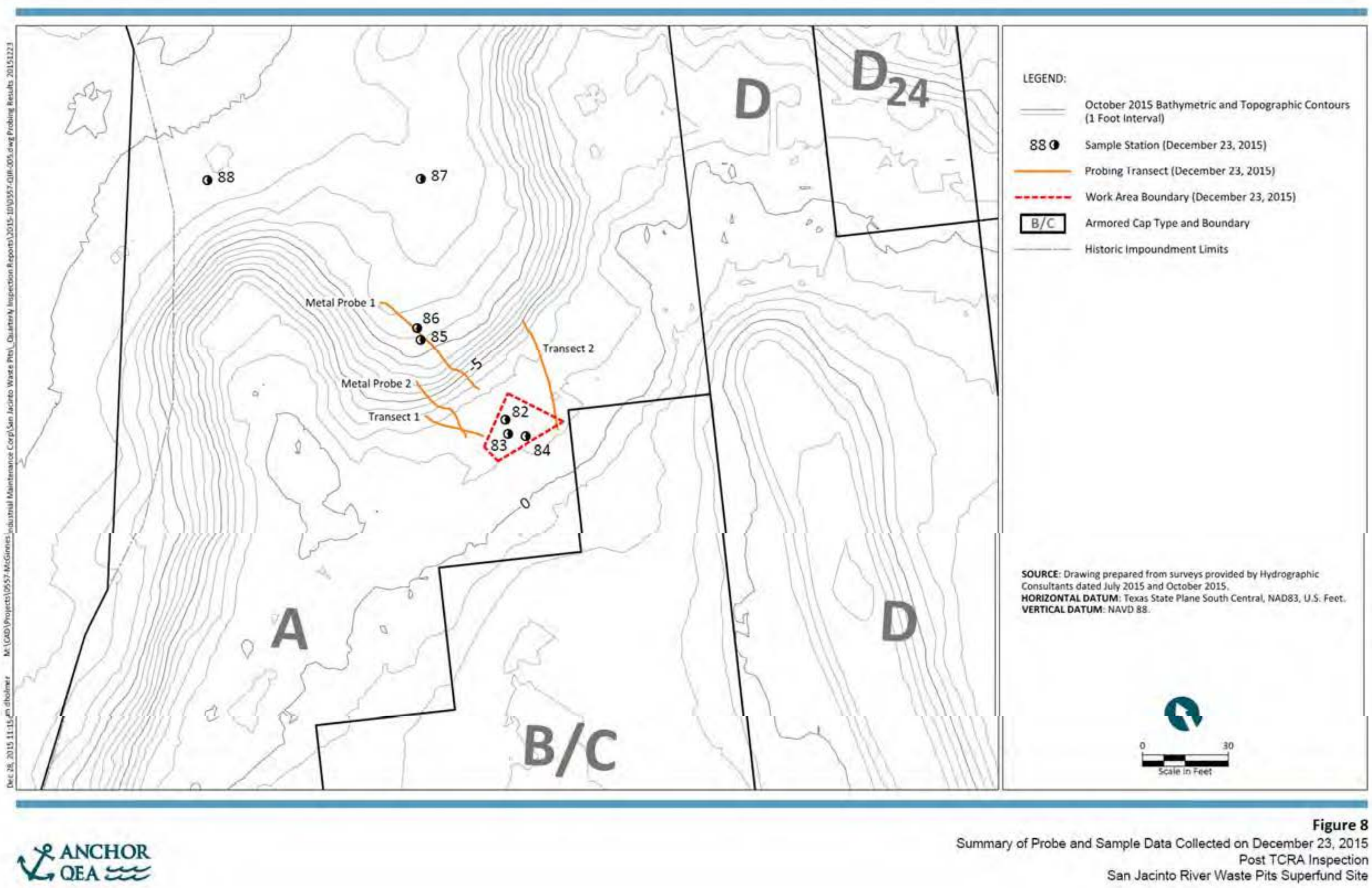

Figure 9. Dioxin and Furan Fingerprints for 2015 Sediment Samples Collected from Within the Delineated Area.

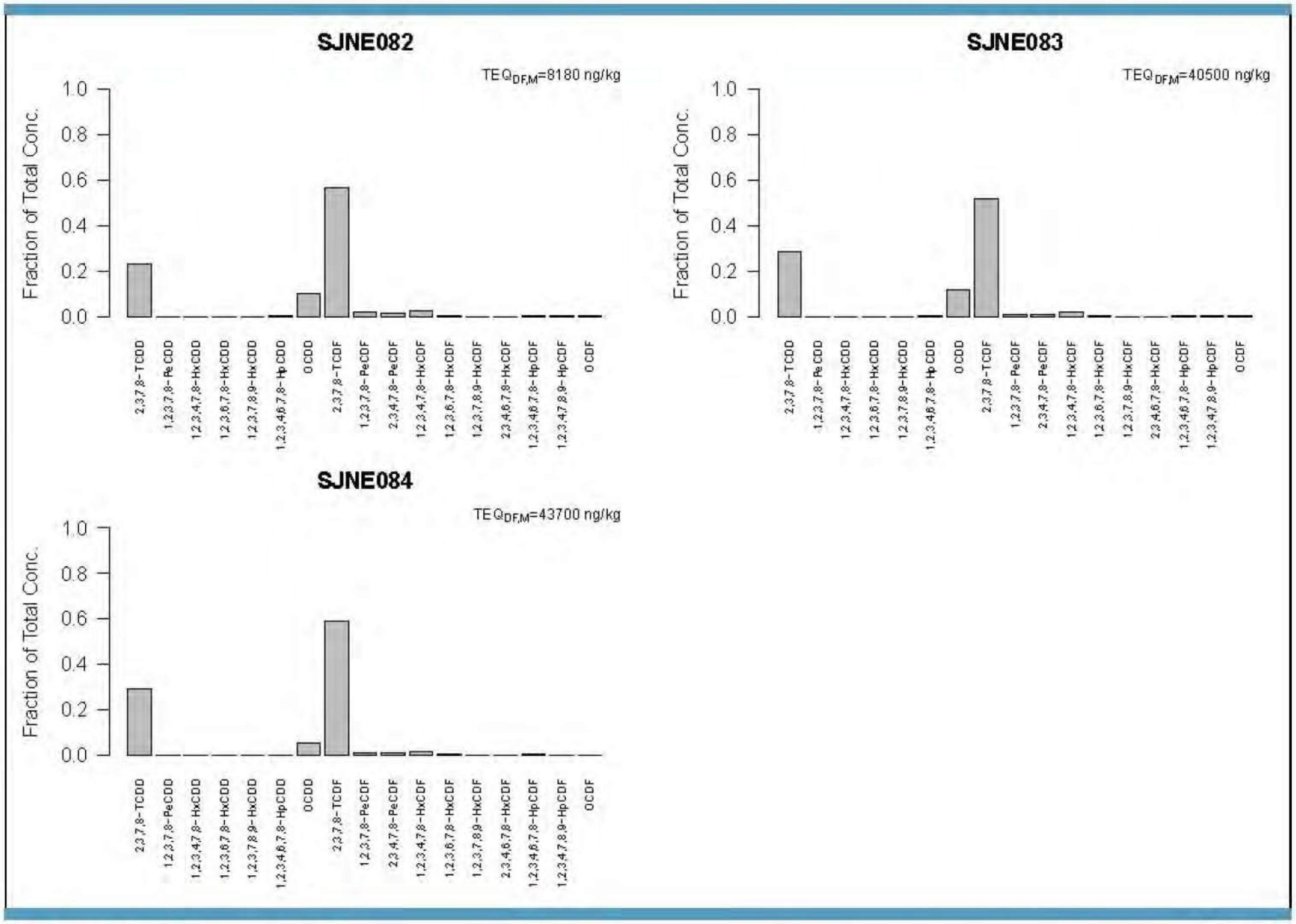

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Figure 9

Dioxin and Furan Fingerprints for 2015 Sediment Samples
Collected from Within the Delineated Area
SJRWP Superfund/MIMC and IPC

Figure 10. Dioxin and Furan Fingerprints for 2015 Sediment Samples Collected from Outside the Delineated Area.

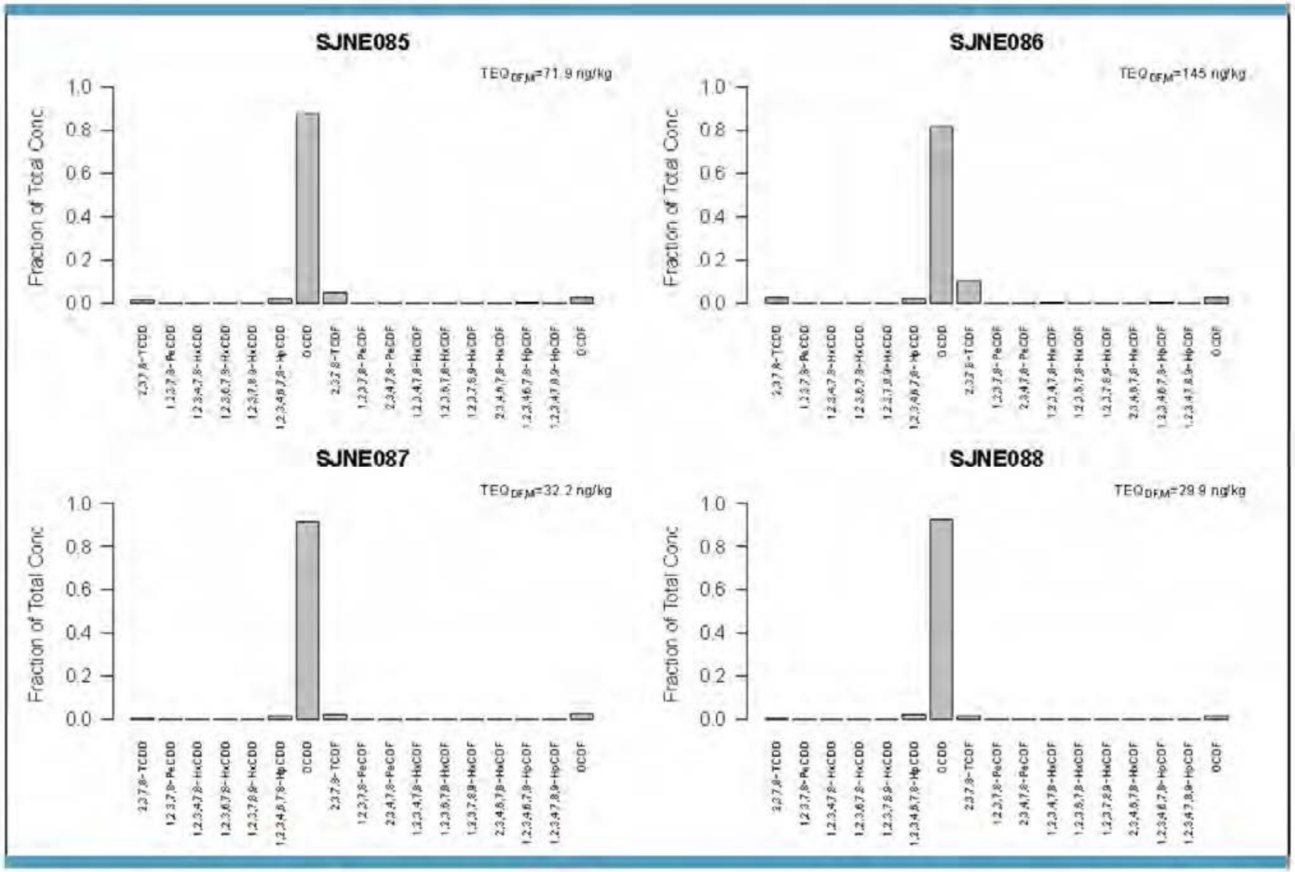

Figure 10

Dioxin and Furan Fingerprints for 2015 Sediment Samples Collected from Outside the Delineated Area

SJRWP Superfund/MIMC and IPC

Figure 11. TEQDF Concentrations (ng/kg dw) in Surface Sediment and Soils Within and in the Vicinity of the Northern Impoundments.

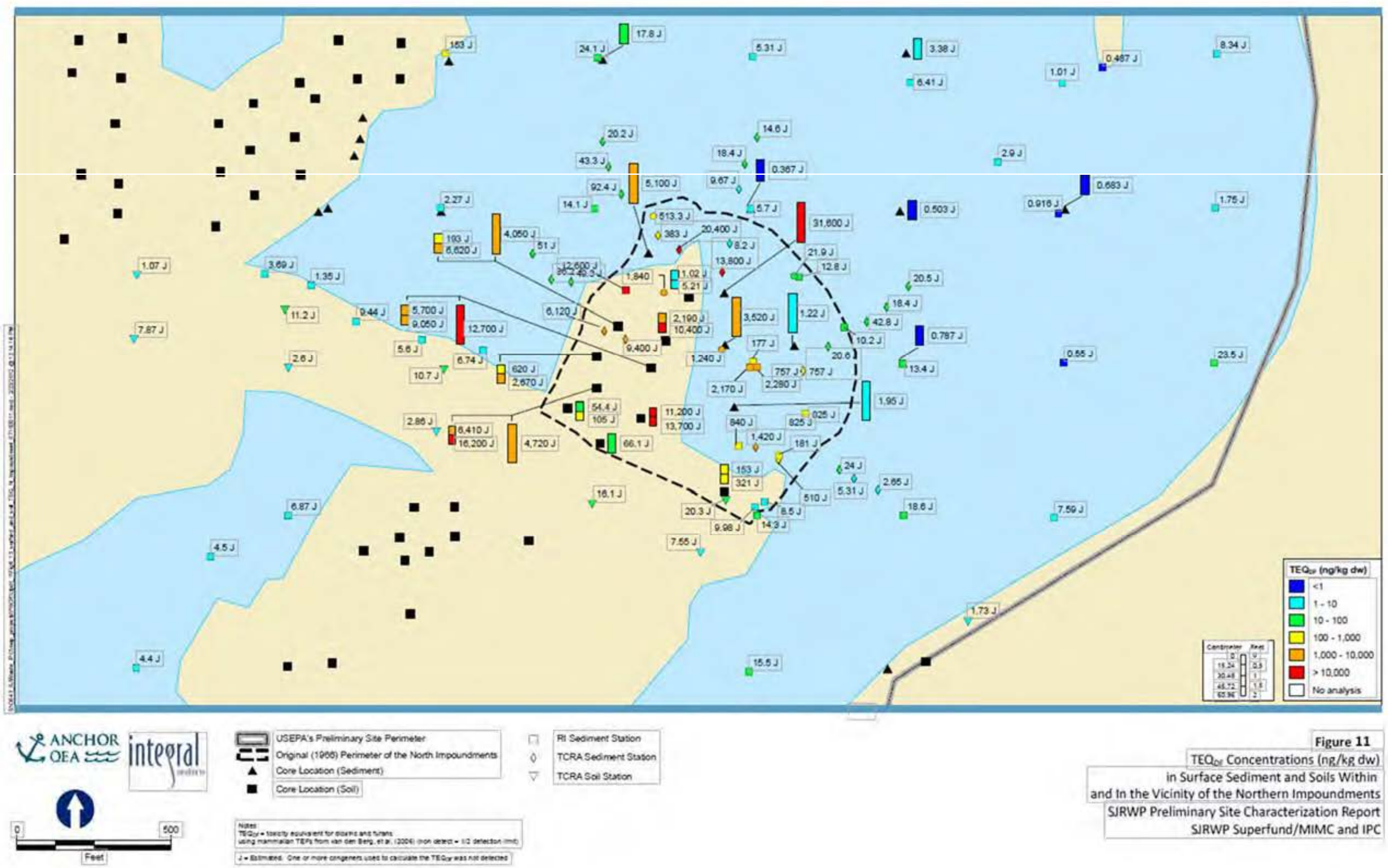

Figure 12. Patterns of Dioxin and Furan Congeners in the End Members of the Best Fit Unmixing Model.

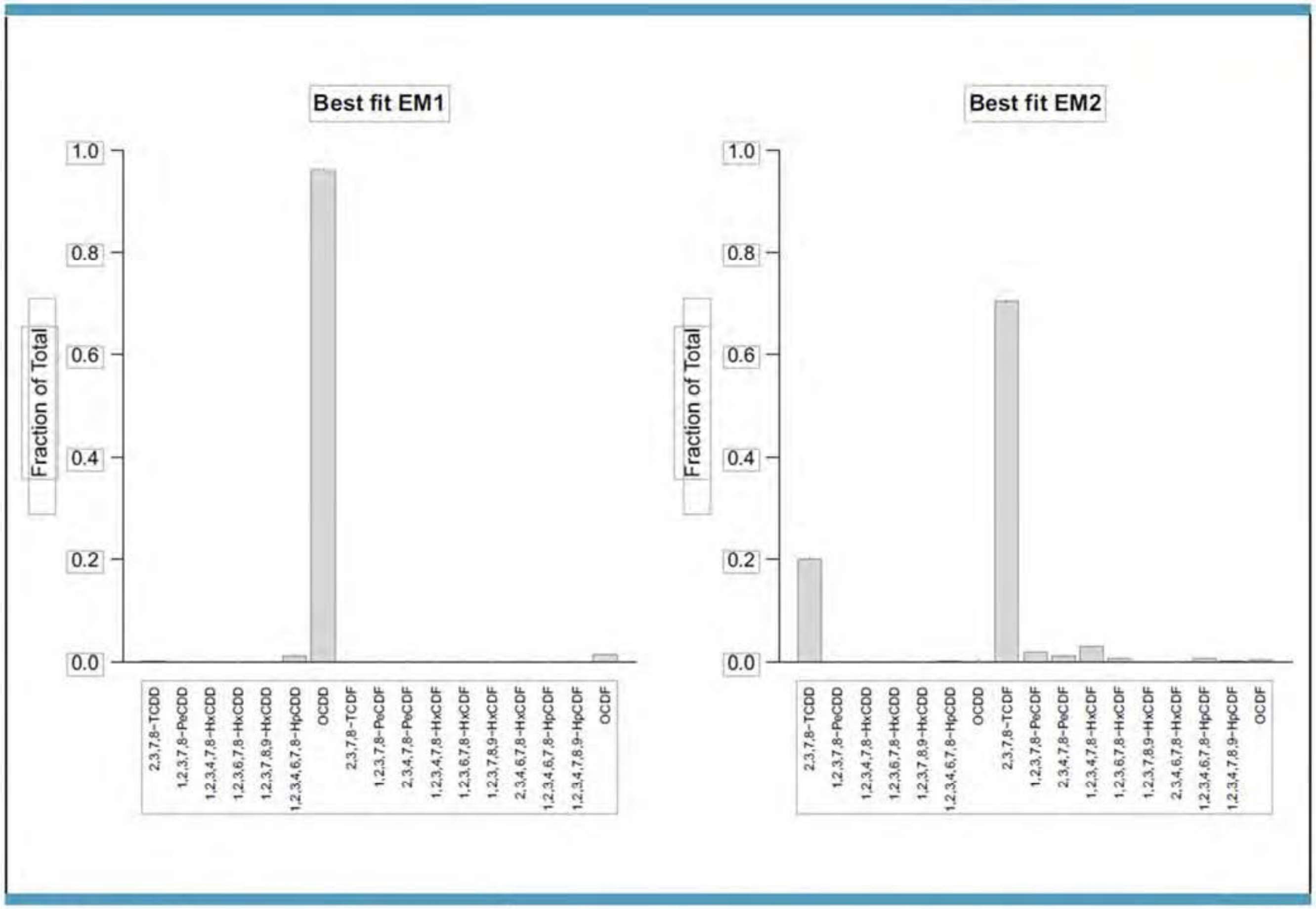

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Figure 12
Patterns of Dioxin and Furan Congeners in the End Members of the Best Fit Unmixing Model
SJRWP Preliminary Site Characterization Report
SJRWP Superfund/MIMC and IPC

References

Anchor QEA. 2012. “Revised final removal action completion report San Jacinto River Waste Pits Superfund Site,” Prepared for U.S. Environmental Protection Agency, Region 6, on behalf of McGinnes Industrial Maintenance Corporation and International Paper Company. http://galvbay.org/docs/SJRWP_Final_RACR_May%202012.pdf.

Anchor QEA. 2014. “Draft final interim feasibility study report San Jacinto River Waste Pits Superfund Site,” Ocean Springs, MS.

Hayter, E.J., Schroeder, P.R., Rogers, N., Bailey, S., Kreitinger, J., Channell, M. 2015. “Evaluation of the San Jacinto Waste Pits Feasibility Study Remediation Alternatives,” Letter Report, U.S. Army Engineer Research and Development Center, Vicksburg, MS.

Appendix A

Figure A1 shows the area where the EPA dive team found the deficiency area. Figures A2-A5 shows the site from different angles and views. All the pictures show that there is a ridge, mostly the berm of the original impoundment that is higher than the deficient area (elevation of the rocks); in particular Figure A4 and A5. Figure A5, the area after repairs; show that the only possible strike would have to occur between the two rock ridges, since neither ridge shows any impact. Figure A6 shows the ridges around the deficient area from the northeast view; no impact on the rocks on either site of the impacted area can be observed. Figure A7 shows the impacted area delineated after the probing.

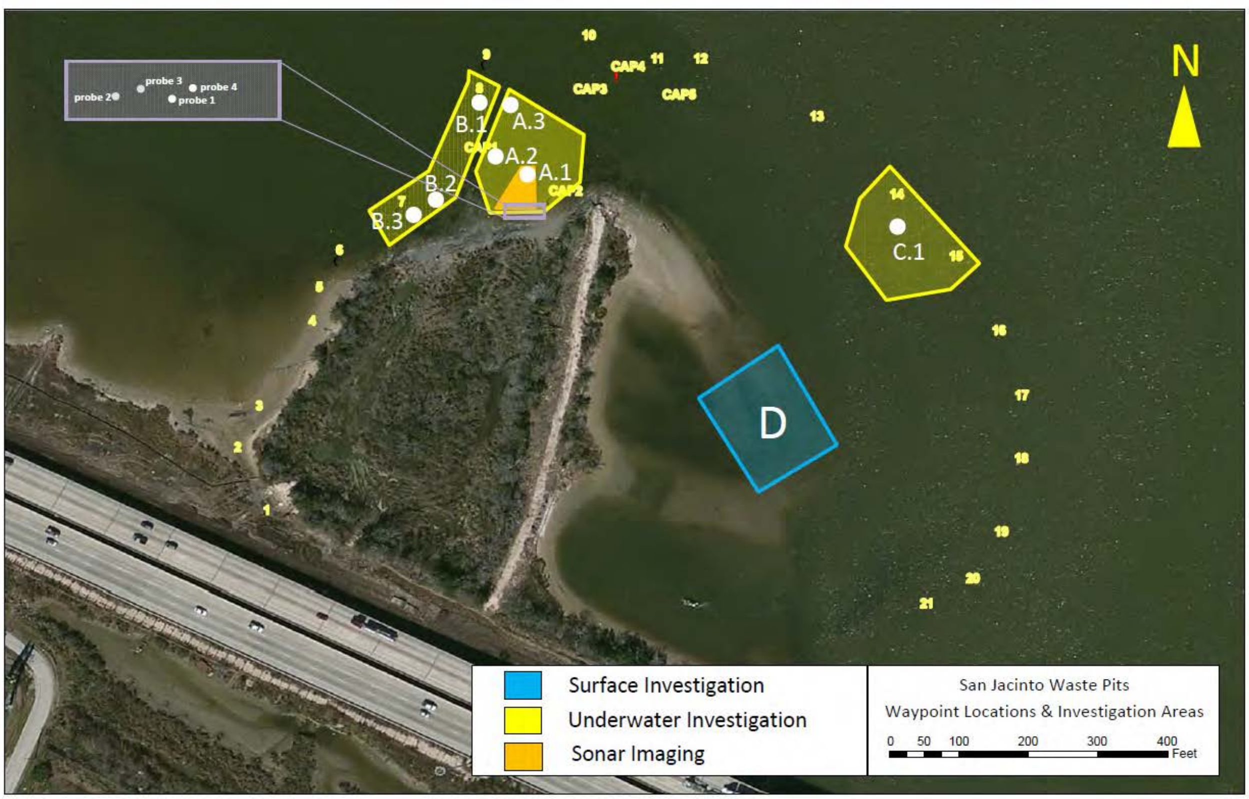

Figure A1. Site investigation area.

Figure A2. Site investigation work area.

Figure A3. Deficiency area marked with pvc pipe.

Figure A4. Top view of the site investigation work area.

Figure A5. Site investigation/maintenance area after repairs.

Northern edge of Western Cell (view northeast). December maintenance area marked with arrow.

Figure A6. Northeast view of the site investigation/maintenance area after repairs.

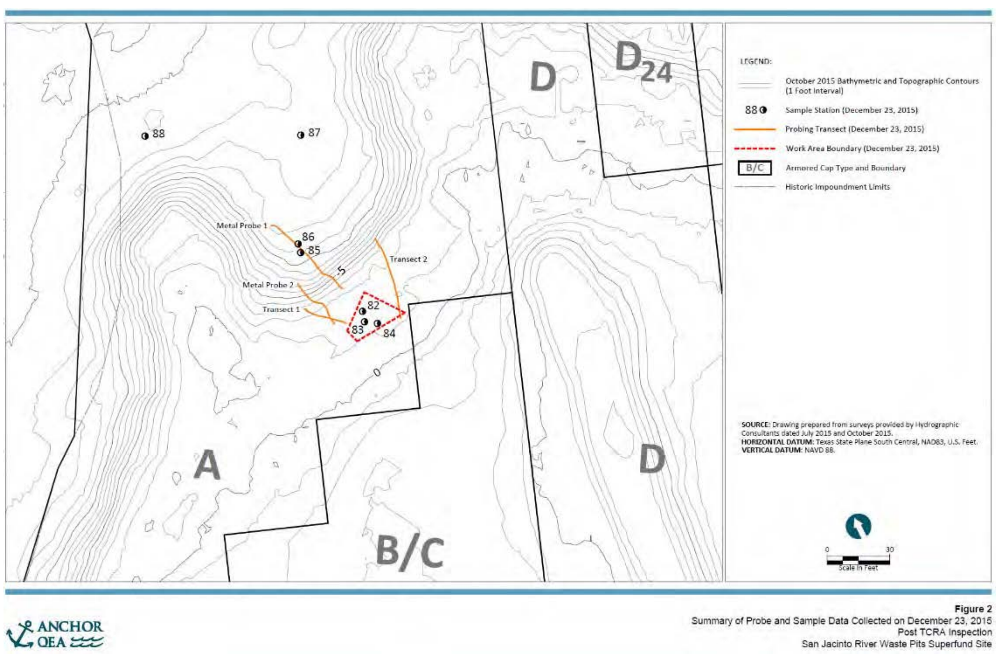

Figure A7. Work area boundaries and sample collection.

Looking at the area of impact/deficiency as delineated in Figure A7 shows that angle of impact from a barge/tug strike should had occurred from the northwest (where sample 82 was collected, toward sample 83, see Figure A8). That follows the wedge that a tug would had created. The difficulty with that strike is that there is a ridge on that side of the deficient area as shown in Figures A2-A6, and that ridge/rocks on that area do not show any impact or disturbance (see Figures A5 and A6).

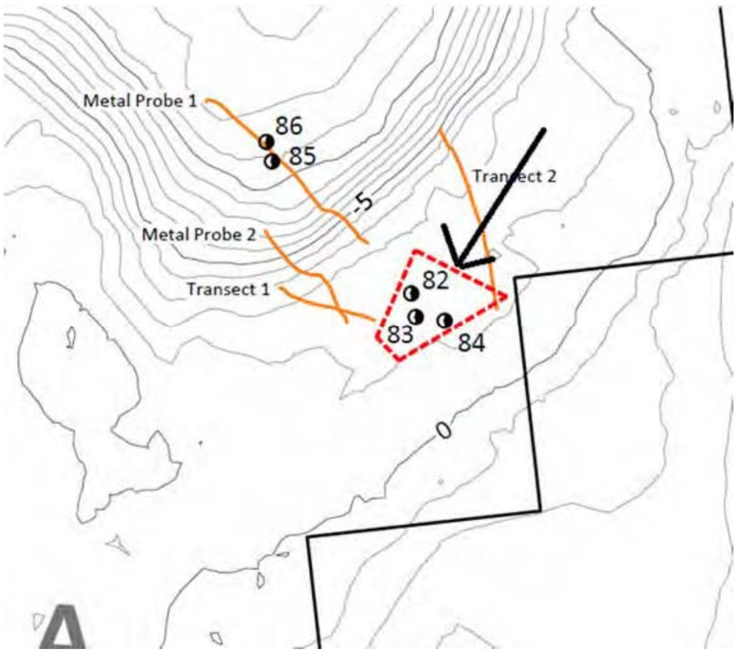

Figure A8. Strike direction.

The other potential strike as shown in Figure A9 is from the west side, again the ridge/rocks on that side (see Figures A5 and A6) show no disturbance.

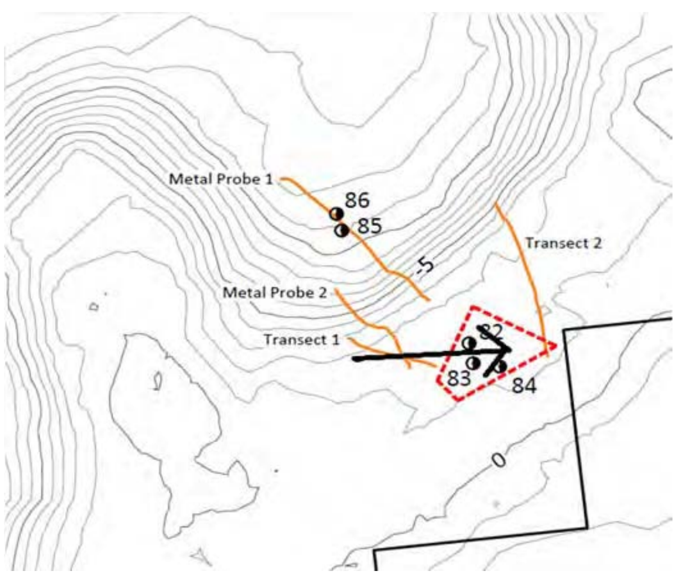

Figure A9. Second strike direction.

So based on the angles, the lack of impact around the surrounding areas where the approach would have occurred, and the lack of depression in the deficiency area we can say that a barge/tug strike was very unlikely.

Appendix B

Figure B1 shows the area where the EPA dive team found the deficiency area and was later repaired. The Figure also shows ground surveys from 2011 till 2015, an eastern transect A-A and a northwestern transect B-B, and the probing locations that defined the defect area. The B-B transect clearly shows that part of the defect area was showing a dip in elevation or subsidence since 2013 and maybe even 2012. Figure B2 shows the elevations for transect B-B in more detail; the subsidence starts in 2013 (at least two inches as compared to 2012) by 2014 the subsidence is at least 8-12 inches. The fact that we see a gradual loss or dip in elevation points to subsidence rather than impact. The cause of the subsidence is probably due to lack of support of the larger rocks in the upper cap layer. This area does not have a geotextile under the cap, so if the filter layer under the cap was not properly placed or if the mud underneath exhibit decay or uneven consolidation, then the rocks would begin to sink causing subsidence of the area. In the future it would be very useful to collect bathymetry and ground surveys prior to repairing the cap due to either scheduled maintenance or probing. The collected bathymetry or surveys would be extremely useful in understanding the cause of an event that resulted in a repair or assessment.

Figure B1. Bathymetric and topographic surveys for the defect area.

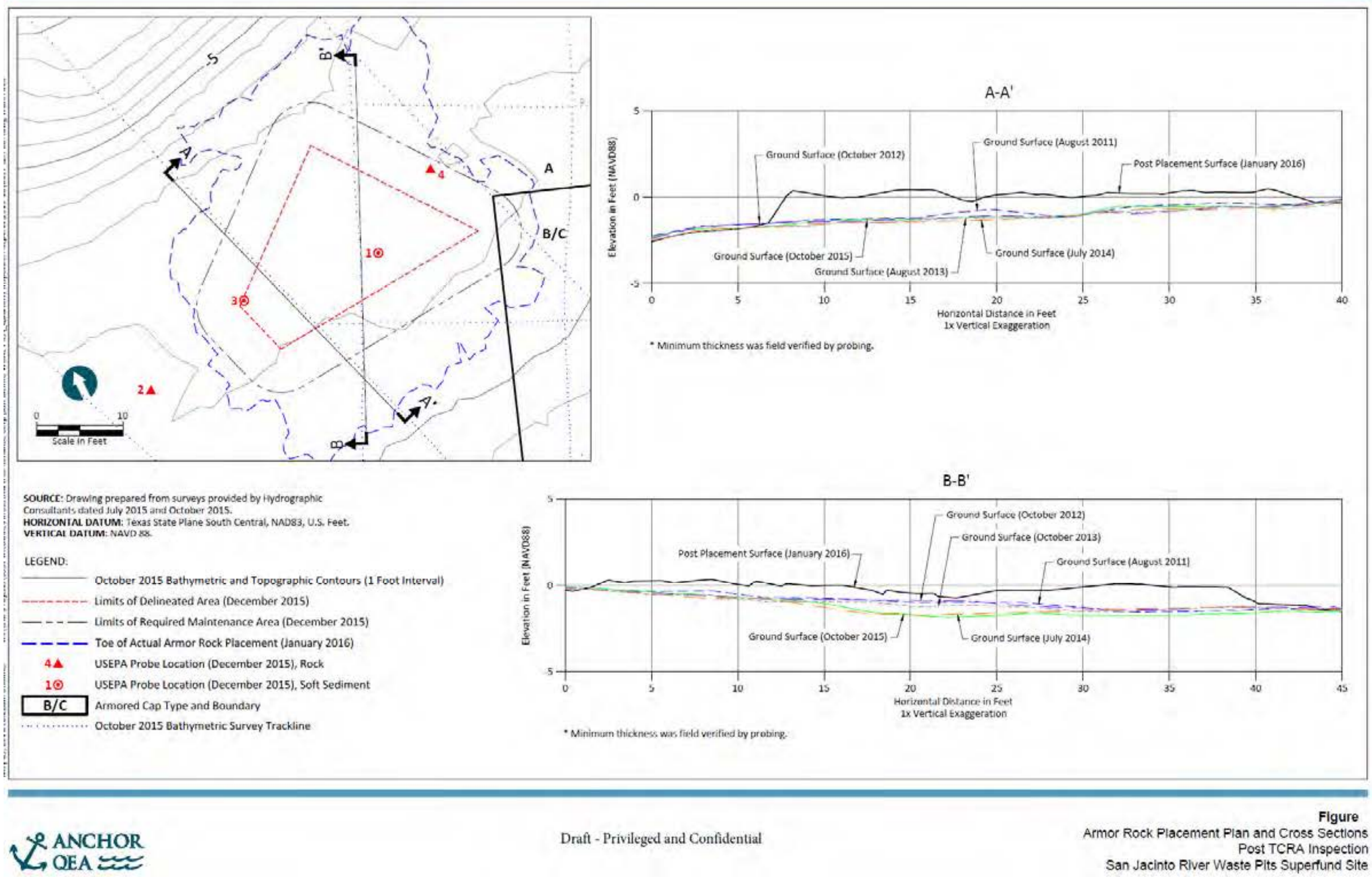

Figure B2. Ground survey at the defect area: transect B-B.